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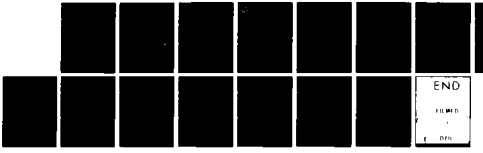

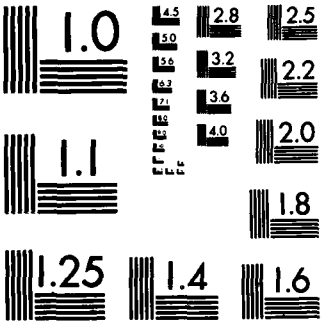

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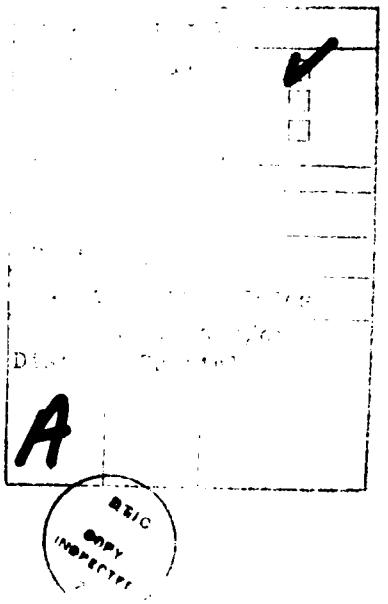
The Artillery Computer System (ACS) is required to replace the M18 Gun Direction Computer (FADAC). The required IOC is 1986. The ACS will be used to perform technical fire direction at the artillery battery and will have the capability of supporting currently required doctrinal combinations of centralized and decentralized tactical and technical fire direction at the artillery battalion. ACS will interoperate with the Digital Communications Terminal and the Marine Integrated Fire and Air Support System (MIFASS) when fielded.



DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, D.C. 20380

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Ref: (a) MCO 3900.4B

Encl: (1) ROC No. SPA-1.06 (Artillery Computer System)

1. In accordance with the procedures set forth in the reference, ROC No. SPA-1.06 for an Artillery Computer System is hereby established and promulgated.

Eugene B. Russell

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DEPUTY CHIEF OF STAFF FOR RD&S

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REQUIRED OPERATIONAL CAPABILITY (ROC)
FOR AN
ARTILLERY COMPUTER SYSTEM (ACS)

1. STATEMENT OF THE REQUIREMENT. The Marine Corps requires an Artillery Computer System (ACS) to replace the M18 Gun Direction Computer, also known as the field artillery digital automatic computer (FADAC), and to exploit the capabilities of other existing and developmental artillery and communications systems in order to enhance mission effectiveness and battlefield survivability of the artillery. The ACS will be a computer system which will provide tactical and technical information recording, processing, computation, manual entry, display, control, and digital transmission of technical firing data from the battery to individual artillery weapons. It will also provide for the receipt and processing of digital requests for fire from forward observers and artillery liaison officers equipped with digital communications terminals (DCTs) and for the digital transmission of appropriate fire-mission related messages to forward observers and liaison officers. The ACS, employed in conjunction with the improved meterological data system (MDS), M-90 velocimeter, cannon-launched guided projectiles, and digital communications capabilities, will contribute to achieving the required around-the-clock , all weather, timely, accurate artillery support. The ACS will consist of a computer unit, computer program(s), display/entry system, power supply, and ancillary equipment. For use at the battery, it will include Gun Displays (GDs) and Section Chief Displays (SCDs) to digitally communicate fire commands from the battery level ACS to the individual howitzer sections either by wire or radio. ACS will be utilized to perform technical fire direction at the artillery battery and will have the capability of supporting currently required doctrinal combinations of centralized and decentralized tactical and technical fire direction at the artillery battalion. With the introduction of the Marine Integrated Fire and Air Support System (MIFASS), the ACS will interoperate with it and will comprise the battery level extension of MIFASS. An initial operational capability (IOC) of 1986 is required.

2. THREAT

a. General. The general threat to the Fleet Marine Force is described in the Marine Corps Long-Range Plan (MLRP) and the Marine Corps Mid-Range Objectives Plan (MMROP).

b. Specific. Recent battlefield experience and analyses have proven the value of well-coordinated combined arms and have resulted in a renewed recognition of the importance of field artillery. Tanks operating unsupported against infantry are vulnerable to antitank guided missiles and guns. Close air support aircraft are increasingly vulnerable to frontline air-defense weapons. Artillery remains the principal supporting arm with the capability of providing around-the-clock, quick-reaction, all-weather support. This has resulted in widespread programs by potential belligerents to improve their artillery capabilities and counter the effectiveness of our artillery. Guided projectiles will give artillery a first-round hit capability; special munitions will greatly increase lethality. Cannon and ammunition with greater range capabilities and increased lethality are being developed. Target acquisition systems, to include counterfire radars for determining artillery and mortar locations, laser rangefinders, passive night-viewing devices, and other new and improved ground and airborne sensors will result in an order-of magnitude improvement in target location capabilities. Improved meteorological systems, velocimeters, and position location equipment will improve accuracy and reduce the requirement for registrations. These developments are either already part of the

arsenal of potential belligerents or will be readily available to them in the midrange period. Enemy artillery which exploits the capabilities of these developments can be expected to be far more accurate and lethal than in the past. Enemy artillery will displace frequently to reduce the vulnerability to counterfire without an appreciable degradation of effectiveness. Marine Corps artillery will be increasingly vulnerable to intense counterfires of increased lethality and, against some potential enemies, will be outnumbered and outgunned. The increased tempo of a fluid battlefield will place a premium on rapid, accurate delivery of field artillery fire against fleeting and mobile targets.

c. Operational Deficiency

(1) The existing means of performing tactical and technical fire direction of Marine Corps artillery is primarily a manual system in which all information is passed by voice via radio, wire or directly person-to-person. Computations are made using a map or firing chart, graphical firing tables, slide-rule, plotting equipment and the M10/M17 plotting board. The system is augmented at the artillery battalion and battery fire direction centers (FDC) with the FADAC and with programmable handheld calculators. Replacement of the existing battalion system with MIFASS is projected to start in 1987. Specific current deficiences are:

(a) The FADAC currently used by both the Army and the Marine Corps to calculate ballistic solutions for artillery techncial fire direction and survey problems was fielded in the mid-1960s. It is beyond its intended service life, has poor maintainability and reliability, is slow, has a low operational availability and requires extensive error-prone manual interactions.

(b) The existing, predominantly manual system falls far short of the state-of-the-art for providing accurate and timely support. While technically capable of acceptable accuracy, the existing system contains so many complex human interactions and computations that the timeliness and accuracy of support frequently falls short of what is required. Some procedures are so laborious, error-prone, and time consuming that they are seldom used, thereby sacrificing capabilities that could otherwise be exploited. For example, the manual method for computing special corrections is seldom used because of the urgency to get fire on the target. Firing data are normally computed as a battery center solution without special corrections for individual weapon distribution or target size and orientation. When weapons are widely dispersed to reduce vulnerability to counterfire, timely computation of special corrections to the firing data for each individual weapon in order to obtain the desired fire distribution on the target is required.

(c) All communications in each step of the fire direction process are oral. This includes forward observer initiation of the mission, computation of firing data and relay of firing commands by voice to the weapons. Each relay provides additional possibilities for errors such as number transpositions, incorrect readbacks, etc.

(d) The preparation of artillery fire plans is a slow, laborious process and is not responsive to changes in the tactical situation that require revision of the plans on short notice.

(e) The existing system does not provide a timely capability for attacking moving targets and will be marginally capable of employing the new inventory of precision guided munitions.

(f) The existing system does not provide the desired speed and accuracy for computing corrections based on meteorological data and registrations.

(g) Programmable handheld calculators have been procured by the Marine Corps to improve overall FDC operations by augmenting the manual chart and FADAC capabilities. The handheld calculator is not a suitable FADAC replacement. It does not provide a digital communications capability, and it does not have the required computational capabilities stated in the 12 Mar 1979 Study, titled "A Comparison of Alternative Systems for Meeting Marine Corps Requirements for a Replacement for the M-18 Field Artillery Digital Automatic Computer (FADAC)."

(h) The MIFASS is not required to provide a fire direction computer or terminal at the battery level. On the future battlefield which may be characterized by extended frontages, wide separation between units, and increased tempo of operations, decentralized technical and tactical fire direction will require a capable system at the battery. Requirements of helicopter-borne operations, independent Marine Air Ground Task Force (MAGTF) operations, and terrain oriented gun positioning are other considerations that require an increased capability at the battery level.

3. OPERATIONAL AND ORGANIZATIONAL CONCEPTS

a. The Marine Corps will employ the ACS to replace the FADAC M-18 computer and manual fire direction procedures in all Marine Corps artillery batteries.

b. The employment of ACS will be compatible with and support current doctrine for the employment of field artillery.

c. The ACS, when employed at the artillery battery, will provide a digital communications link between cannons with gun control units (GCUs) and the battery FDC exercising technical fire direction. The ACS will interoperate with GCUs using digital data communications over both field wire and radios organic to the artillery battery. The ACS, used in conjunction with the DCT, will provide digital links among forward observers, artillery liaison officers with infantry battalions, and the artillery battlion FDC and/or battery level ACS, as appropriate, using field wire and/or radios organic to the artillery unit.

d. The ACS will be designed to meet battery requirements for centralized and decentralized tactical and/or technical fire direction.

e. The ACS will incorporate an automated assisted (operator action required prior to messages being entered into memory) interface with the Meteorological Data System (MDS) and the DCT. ACS will also be compatible with and incorporate an automated interface with MIFASS when MIFASS is fielded.

f. The ACS will be employed in all phases of amphibious operations, during subsequent operations ashore and in garrison training. It must be capable of operation in all climatic conditions and geographical locations in which a MAGTF may be employed, with no requirement for shelter or controlled environment except as may be required for operator effectiveness or system mobility in accordance with AR 70.38.

g. The introduction of ACS will not require additions to the present artillery tables of organization. The system will be operated by Marines with field artillery fire control or field artillery operations Military Occupational Specialties (MOS 0844 and 0848). The present procedures of preparing operators by a combination of formal schooling and on-

the-job training should be adequate. Operators and FADAC Repairman (MOS 2885) at the using unit will be capable of performing organizational maintenance. Any maintenance of the system beyond that which can be accomplished at the organizational level will be performed at the intermediate level by Marines with electronic maintenance Military Occupational Specialities (MOS 2885 FADAC Repairman). The introduction of the ACS will require no additional intermediate level maintenance personnel. The impact on training intermediate level maintenance personnel will be minimal. Depot level maintenance (the repairing of circuit boards) will be conducted at U.S. Army Depots in accordance with the Memorandum of Agreement. To ensure that training and support requirements for the ACS are adequate, the development program will include:

(1) A maintenance concept.

(2) Manpower and personnel requirements.

(3) Supply support requirements.

(4) Support and test equipment requirements.

(5) Training and training equipment requirements.

(6) Technical data (to include ILS, TM's, and Depot Maintenance Work Requirements).

(7) Software support will be addressed in computer resources support requirements.

(8) Packaging, handling, storage and transportation requirement.

(9) Maintenance facilities requirements.

4. ESSENTIAL CHARACTERISTICS

a. Functional Characteristics

(1) The ACS computer will:

(a) Perform fire direction computations using stored programs for all Marine Corps cannon weapons and associated munitions to include the 14.5mm Training round. Accuracy of the ballistic computations will be within the criteria set forth in U.S. Army Ballistics Research Laboratory Modified Point Mass Model.

(b) Use the standard ABCA target numbering system to identify targets.

(c) Provide technical fire direction functions that will compute firing data for:

1 Area missions, including those for the attack of irregularly shaped targets, the application of special corrections, zone fire, shifting fire, time on target and sheaf changes, e.g., converged, parallel, special or open.

2 Destruction missions.

3 Registration missions, to include precision high-burst, mean point-of-impact, and radar.

4 Illimination, to include single, two-point, four-point and coordinated illumination.

5 Air-observer missions with adjustment along the gun target line.

6 Improved conventional munitions, smoke, Rocket Assisted Projectile and chemical munition missions.

7 Nuclear missions.

8 Missions utilizing laser-generated target or projectile point-of-impact information (slant range, vertical angle and azimuth).

9 Assault fire missions.

10 Precision guided munitions missions.

11 Prediction of moving-target locations.

12 Requests for fire (including subsequent adjustment) with target location designation by the use of UTM coordinates, polar plot or shift from known point.

13 Task organized artillery units that are composed of as many as three calibers of indirect fire weapons.

(d) Maintain a file of forward observer (FO) or observation post (OP) locations and identification codes or call signs for up to ten (10) observers.

(e) Clearly identify fire mission and originating observer or sensor.

(f) Record a running ammunition, fuze, shell, lot and powder count.

(g) Provide for digital (Message from MDS) and manual meterological data input.

(h) Correction of firing data as appropriate, for meteorological conditions, powder temperature, individual weapon displacement from battery center (horizontal and vertical), individual weapon muzzle velocity and registration corrections.

(i) Provide the capability of performing artillery survey computations, including conversion of rectangular grid to polar; polar data to rectangular grid; zone-to-zone transformation; and computation of grid coordinates from intersection, resection, triangulation and traverse.

(j) Provide for the computation and storage of firing data for three concurrent fire missions and for one (1) final protective fire (FPF).

(k) Provide for the generation of eight separate sets of complete weapon fire commands to be displayed at the ACS concurrently and at the appropriate SCD/GDs. Time in seconds from the initiation of computations to completion of firing command display for all ranges, charges and calibers will not exceed 3.5 seconds, 2.5 seconds desired.

(l) Provide for the receipt, storage, computation and transmission of at least 100 fire plan targets organized into up to ten separate fire plans. Targets will be capable of being transmitted as individual targets or a complete list of targets and deleted by plan name or target designation. A summary display of targets by plan will be provided on command.

(m) Provide for updating target and fire plan files with ballistic and position corrections as specified in paragraph 4.a. (1)(h) above, upon operator command.

(n) Provide a method to output a nonvolatile record of fire mission data, fire plan schedule of fires and data recalled from the data base.

(o) Provide for the receipt, editing, processing and transmission of both fixed format and free text messages to include an authentication table and a means of serialization.

(p) Provide for operator-controlled purging of designated stored data and for output of appropriate warning messages or signals for illegal operator procedure or an invalid computer solution.

(q) Provide for the recall, display and editing of all variable input data.

(r) Provide both manual and automatic system operation.

(s) Provide both visual and audible signals for critical operational conditions.

(t) Simplify operator procedures by using system prompts and error messages to guide the operator.

(u) Allow ease of data entry with minimal training and fatigue to the operator.

(v) Allow the operator to assign priority order to the forward observers.

(w) Alert operator (both audio and visual) when a priority mission is received.

(x) Warn the operator when safety limits are exceeded for mask, intervening crest, deflection and elevation limits.

(y) Warn the operator when fire support coordination measures are violated such as no fire areas fire support coordination line and coordinated fire line.

(z) Allow the operator to select priority fire missions for immediate fire.

(aa) Provide four communications channels each of which allows wire or radio communications, using equipment organic to the artillery battery.

(bb) In addition to the four communications channels, be able to interface with a standard printer (GFE). System operation will not, however, be dependent upon a printer for mission accomplishment.

(cc) Provide protected program storage in a manner to prevent inadverent modification or deletion of the stored programs by operator action.

(dd) Have computer programs that will allow new, revised, or alternate caliber/weapon programs to be loaded into the system by Force Service Support personnel.

(ee) Have a memory reserve of at least 25 percent of capacity above that required for performing the desired functional requirements to allow for system growth.

(ff) Have a built-in-test capability to monitor system operation including system power and to detect and isolate system/equipment faults down to lowest replaceable unit.

(gg) Provide for the connection of automated test equipment for depot level maintenance.

(2) Two GDs and a SCD will be provided to each howitzer section to display data digitally transmitted from the computer unit via wire or radio. The display will:

(a) Possess legibility and brightness characteristics to enable the section chief, gunner and assistant gunner to accomplish missions during daylight or darkness.

(b) Display the appropriate information. The section chief's display (SCD) will provide alphanumeric display for pieces to follow command, method of fire, method of control, pieces to fire, number of rounds, shell, fuse type, ammunition lot, charge, fuse setting, deflection, quadrant elevation, command to fire, check firing and end of mission. The device for the section gunner will display only deflection and the device for the assistant gunner will display only quadrant elevation.

(c) Provide a visual indicator and audio signal for fire mission alert and check fire, and a visual indicator for the command to load.

(d) Provide a means of acknowledging commands and indicating the section ready, rounds fired and rounds complete.

b. Physical Characteristics

(1) ACS must be capable of operating unsheltered in the field, in standard Marine Corps shelters, aboard ship for training purposes, and while being transported in tactical vehicles. The operation of ACS aboard ship does not require any interface with shipboard communications or power systems. Conditions under which the system must operate include extremes of temperature and humidity, blowing sand or dust, heavy precipitation, day and night, and the salt air environment attendant to amphibious operations in accordance with AR 70.38.

(2) Equipment must be able to withstand vibration and the shock of rough handling and location in proximity to artillery and other high concussion weapons and will be operable after temporary immersion in saltwater while secured in their normal cases.

(3) The computer unit will weigh no more than 30 pounds (lbs) (13.61 kilograms (kgs)), desired weight (including batteries) not to exceed 25 lbs (11.34 kgs). The section chief display shall weigh no more than 15 lbs (9.07 kgs), desired weight not to exceed 5 lbs (2.27 kgs). Devices for the section gunner and assistant gunner will weigh no more than 5 lbs (2.27 kgs), desired weight not to exceed 3 lbs (1.36 kgs).

(4) The computer unit will be capable of operating from:

(a) Self contained batteries which are standard DOD primary and secondary batteries that are physically interchangable, for six hours of continuous use without charging/recharging required, twelve hours desired. Rechargeable batteries (secondary) will recharge when system converts to external power.

(b) Twenty-four-volt (24-volt), direct-current (24 VDC) batteries that are not self contained.

(c) Standard Marine Corps mobile electric power generating sources (MEPGS).

(d) Standard garrison power (60 cycle, 120 volts).

(e) GDs will utilize standard batteries and/or vehicular electrical system of self-propelled weapons.

(5) Interconnection of various equipment components will use standard military cables and cable connectors. Two categories of cable are permitted, one for signals and one for power. Each must be quickly and easily distinguishable and not be interchangeable.

(6) The ACS will be capable of being mounted with associated equipment for vehicle operations.

(7) ACS will be constructed so that it will survive, outside of any shelter, the same nuclear blast and radiation levels that personnel operating the system will survive. The ACS will also survive the effects of nuclear electromagnetic pulse (EMP).

(8) The system will provide for secure radio data communication for classified materials up to and including SECRET RESTRICTED DATA. (Internal battery circuits between the computer unit and the SCDs/GDs will be excluded pending approval of the KYV-2A for data communications). Government furnished communications security device(s) will be used.

(9) TEMPEST and MIL-STD-461(A) requirements for emission control must be met.

(10) Reliability, the probability that an item will perform its intended function for a specified interval under stated conditions, is expressed as mean time between failures (MTBF). ACS and GCU reliability will be such that they have a MTBF of not less than 1,000 hours, 1500 hours being desired.

(11) The operational availability of ACS and GCUs must be 99.9 percent. Operational availability is defined as the probability that a system is in an operable and committable state to perform its mission at any random point in time. It is expressed quantitatively as the ratio of total operating time to total time. It is calculated using the follow equation:

$$\text{Operational Availability } (A_o) = \frac{TUT}{TUT + TDT}$$

TUT = Total up time
TDT = Total down time

(12) The ACS design will provide for use of diagnostic software and automatic test equipment to achieve the maximum manitainability at the organizational and intermediate levels. Maintenance will consist of fault detection and isolation utilizing built-in diagnostics, indicator circuitry and automated test equipment.

(a) Repair of the ACS will be accomplished by the interchange of replaceable modules at the appropriate maintenance level. No maintenance adjustments are to be required during operation resulting from time and environmental condition changes.

(b) Mean time to repair (MTTR) the ACS to operational readiness will not exceed 30 minutes (15 minutes desired) for organizational level repairs and one hour for intermediate maintenance-level repairs. Maintenance requirements (organizational through depot level) will be developed in accordance with MIL-STD-1390B.

(c) Scheduled preventative maintenance performed by the using unit (consisting of inspection, servicing, minor repair or replacement, and alignment/adjustment within the capabilities and facilities at that level) will not exceed 15 minutes.

(13) The ACS applications software will be in accordance with DOD Instruction 5000.31 and software documentation in accordance with MIL-STD-1679.

(14) Human engineering design will be in accordance with MIL-STD-1472A and the following additional requirements.

(a) Illumination and contrast levels must support operations in conditions ranging from complete darkness to bright sunlight. Equipment must not cause undue fatigue during an operator's normal watchstanding period (eight hours).

(b) Individual operator actions must not require a high degree of manual dexterity and must be equally suitable for left- or right-handed operators. Any operator keys must provide near instantaneous audible and visual feedback and must be functionally grouped. Furthermore, no combination of operator actions should cause a unit to "lockup" or fail.

(c) Operator errors must be detected as soon as logically possible and presented to the operator, who should be able to correct the error easily.

(d) Memorization of the mnemonic symbols or codes used by the operator will be minimized. The operator must be able to display and review input data and to easily make changes to the data displayed.

(e) Operator will be capable of operating all components while wearing chemical or environmental clothing, specifically protective gloves.

(15) ACS must meet the safety requirements of MIL-STD-454 and MIL-STD-1472A.

(16) ACS must be capable of rapid emergency destruction. The means for destruction need not be incorporatd into the equipment.

(17) Logistics support will be developed in accordance with MIL-STD-1388.

5. OTHER WARFARE AREAS CONCERNED. Not applicable.

6. RELATED EFFORTS

a. Requirements Documents

(1) ROC CCC-1.07 Marine Integrated Fire and Air Support System (MIFASS) of 25 Jul 1979.

(2) ROC CC-1.1 Squad Level Radio AN/PRC-68 of 28 Jan 1963.

(3) ROC-USATRADOC ACN 57473, LIN Z277621, NETP EL-1 Fire Support Team Digital Message Device of 15 Apr 1982.

(4) ROC CCC-1.22 Digital Communications Terminal (DCT) of 7 Aug 1978.

b. Related Projects

(1) Radar, AN/TPQ-36. The AN/TPQ-36 is an Army developed hostile weapon locating radar designed to locate multiple enemy mortar positions which may be firing simultaneously. The system will include the capability for a digital data link with a fire direction computer. The projected Marine Corps IOC for the AN/TPQ-36 is FY 1982.

(2) Fire Support Team Digital Message Device (FIST DMD). The FIST DMD will be an Army developed, small, manually operated device for sending and receiving digital, fixed-format and free-text messages over voice radio nets and wire. The projected IOC for the FIST DMD is 1987.

(3) Field Artillery Radar Chronograph M90 (Velocimeter). The M90 is an Army developed lightweight doppler radar that is attachable to a howitzer to provide timely and accurate determination of muzzle velocities. Use of the velocimeter in connection with an artillery fire direction computer will provide the capability of making muzzle velocity corrections in a timely manner to firing data for individual weapons. The M90 was fielded in FY 81.

(4) Meteorological Data System (MDS). This is an Army program to develop an improved field artillery meteorological system. It will have the capability of providing an automated assisted digital meteorological data input directly to an artillery technical fire direction computer. The projected Marine Corps IOC is FY 1986.

(5) Programmable Handheld Calculator (PHHC). The PHHC has been found suitable for use in enhancing FDC operations until a replacement for FADAC can be fielded. PHHC was fielded in FY 1981.

(6) Battery Computer System (BCS). BCS is an Army program to develop a battery-level fire direction computer to function in conjunction with the Army TACFIRE and to provide Army artillery batteries with a capability for autonomous operation. The projected IOC for BCS is late 1982.

(7) Radio Set AN/PRC-68. The PRC-68 is a Marine Corps developed FM transceiver designed to provide intraplatoon voice communications in the VHF band. The PRC-68 has the capability for employment with an artillery fire direction computer to transmit and receive digital fire command traffic between the Artillery Computer Unit (ACU) and GCUs at the individual howitzer sections. The PRC-68 was fielded in 1981.

(8) Digital Communications Terminal (DCT). The DCT is a Marine Corps developed, small, handheld, manually operated device for sending and receiving digital, fixed-format and free-text messages over voice radio nets and wire. The projected IOC for the DCT is FY 1984.

7. TECHNICAL FEASIBILITY, ENERGY-EFFECTIVENESS IMPACT, AND COST FORECAST.

a. The existing technological state of the art is such that development of the Artillery Computer System (ACS) is considered to be a low technical risk project. The area of greatest technical uncertainty is that of the display and the risk of this component is assessed as medium. Software algorithms and programs used in the Human Engineering Laboratory Battalion Artillery Test 8 (HELBAT "8") on-board gunnery computer can be used in the system development.

b. Since the power source for the system will be battery, the energy effectiveness impact will be minimal.

c. Based on a Marine Corps buy from an Army production line estimated cost per system is $81,000.00. The current estimated RDT&E and PMC funds for ACS are as shown in Table 1. FY 86 Requirements include funding for the development of the MIFASS/ACS interface.

TABLE 1

ACS FUNDS RDT&E AND PMC (in millions)

	Fiscal Year						
Fund Category	81	82	83	84	85	86	87
RDT&E	.001	.435	1.9	.665	2.2	1.0	
PMC					16.0	21.3	15.0
O&MMC TBD							

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